

R.C.M. & E. Test Report

EDITORIAL REVIEW & TEST

BONNER DIGIMITE MULTIPLE PROPORTIONAL SYSTEM

As the name implies the Digimite produced by Bonner Specialties employs Digital computer techniques as a means of effecting proportional control. This particular version of the technique enables one to operate up to eight proportional servos simultaneously without interaction.

Basically elevator, aileron, rudder and engine are controlled by two joy sticks, aileron and elevator on the right hand stick, rudder and throttle on the left. Four auxiliary levers accessible to the left hand are arranged near the top of the Tx. The servos are available in either centre fail-safe or end fail-safe mode so that whilst all the flying control surfaces may be adjusted to neutralise under fail-safe conditions, the engine goes to low speed and if retracting undercarriage systems are used an end fail-safe would be used so that the gear is lowered on fail-safe. Similarly multi engine models could use the auxiliaries for adjusting throttle balance, if two auxiliaries were used for throttle there would also be end fail-safe types.

I wonder how many modellers will need so many proportional auxiliaries, however, the system seems to have accomplished these extra controls with little added circuit complications. Taken stage by stage each section of the circuit is really quite simple but collectively a complete four servo system has no less than 145 transistors and 133 diodes. NPN silicon transistors are used extensively and sub-miniature diodes and other components account for a very compact assembly in each of the system's elements. Pulses are produced at 3.5 M.Sec., the pulse width varies between 1.1 M.Secs. to 2.3 M.Secs. with neutral at 1.7 M.Secs. Each complete frame of 16 pieces of information is repeated 35 times per second. Each control pot operated by the appropriate lever on the Tx adjusts the length of each individual pulse, and a longer timing pulse enables the receiver to keep in step with the transmitter.

If impulse interference or similar radio "noise" is received, a special section of the circuit rejects the complete frame and waits until the next correct frame, i.e., one with the required number of pulses, is received. If for any reason, a completely correct frame does not occur at the receiver output stage for more than 0.8 sec., a fail-safe switch comes into operation, switching in neutral or end position tracks which switch each servo amplifier mechanically to its fail-safe position.

It would seem that by nature of the computer type circuits used that the control response would be precise and by use of good quality components neutral drift would be less likely to occur. The nature of the servo circuit ensures that full voltage



Heading: Complete 4 channel system, large circular power pack can be seen behind Rx. The receiver complete with decoding network appears below.

is applied to the motor whilst it is cancelling the error between command and actual position, irrespective of the amount of error (some proportional servos only apply full voltage at maximum error, a smaller voltage when the error is correspondingly small. With a heavily loaded control surface such a condition reduces the ability of the servo to follow the control stick exactly. Whilst this is relatively important at extreme control positions, it can give what pilots refer to as a baggy neutral).

The Digimite servos move in distinct "notches"; by moving the control sticks very carefully, 100 notches of servo movement were measured each side of neutral, this made it easy to calculate any error. For by dividing the control stick movement into a corresponding number of divisions, this was done by clipping an extension pointer on to the stick and

counting the tiny "steps" in the enlarged trace produced by a dummy control surface on the servo analyser, it was possible to detect any difference in a relative position of the two.

On the example tested position was precise although mechanical float at the output arm of the servo accounted for 5 per cent of the total throw (slightly better than an average reed servo in terms of centring).

The speed of transit was however, quite slow compared with other proportional systems, just how this affects flight performance could not be deduced from the tests we conducted, theoretically a proportional servo should be at least $1\frac{1}{2}$ times, preferably twice as fast as a reed servo. The test figures tell the full story. The particular sample system on test represented sound construction, and the design is well presented, clearly the electronics are the work of the professional computer boys, and the mechanical parts and general layout are borne of long experience in the modelling field, a good combination. . . . The design involving the use of many specially made nylon mouldings and the vast number of electronic components could be one reason why the price is what we consider high for a proportional control system. For this reason we feel we must comment on one or two niggling little points. . . .

The aileron trim lever slipped from time to time particularly if the aileron stick was moved rapidly. This is because the friction lock depends on the springiness of the nylon lever unit which adjusts the neutral position of the stick centring scissors spring unit. In hot weather the nylon would be a little more flexible and the effect more marked. A trim which slips cannot be tolerated.

The ball and socket joint on each control stick is moulded with a very slight flash line which in certain stick positions (the stick can also revolve) caused the right hand stick to jam occasionally. This could have been avoided if the backing plate to the assembly had been correctly adjusted. The stick freed itself with prolonged use under test, but grit from the runway might produce a similar effect. The fit is sufficiently tight on all the auxiliary trim levers and stick bearings to prevent water running into the case on a wet day.

The meter on the Tx did not give a very wide indication between charged and dis-charged rate. The needle went around the 50 per cent mark most of the time.

The receiver lacked range on the test we conducted; a matter of a yard or so with the Tx antenna right off (manufacturer indicates 20 ft.) and about 10 yards with the aerial on but retracted. This may be due to the fact that on arrival, the Rx crystal was open circuit and the outfit was sent to the British servicing department for a replacement and realignment. After the test, a faulty component was replaced in the radio link permitting normal range.

The system is rather more sensitive to interference, or rather the effect of interference on this particular system was more marked than on other superhet outfits tested to date. The frame rejection and fail-safe previously referred to are effective, but with the result that the servos twitch over about 15 per cent of their total travel. This should not affect the flight of a stable model. There is however, a "threshold of fail-safe", a condition which shows itself when weak interference on the same frequency, particularly high power signals at close range on an adjacent channel are radiated when the Digimite Tx is at

relatively long range, low Tx battery condition and high levels of impulse interference are present. The result is that the system attempts to fail-safe and reset itself, between which times any servo which is not on its trim neutral twitches more strongly. At certain levels of interference each servo in turn runs to about $\frac{1}{2}$ deflection in turn sequentially whilst the throttle opens and closes. We did not try specifically to code signals to produce this effect, that would be unfair, unrealistic and unlikely to happen under operating conditions. A variety of ordinary proportional, reed and single channel transmitters were used, any other interference being present in the atmosphere already. This was particularly noticeable when the set was tried at the office compared with operation late at night in a less busy area. In all fairness the manufacturer mentions the likelihood of interference of this kind and it is really up to the intending user of this equipment to see whether the level of interference at his flying field is tolerable or not.

We make no excuse for mentioning again for a fail-safe to be effective the model must be trimmed so that it free flights in a perfectly stable manner with all the servos on their fail-safe neutral positions. This is not easy with an aerobatic model, as reed fliers will know.

This then is the summary of the findings which appeared in the following test; design approach and construction good, response precise, speed slow, reliability depended on operating conditions and not on the first two items.

TRANSMITTER

Physical Data

Size

$8\frac{1}{2}$ x $6\frac{1}{4}$ in. wide — $2\frac{3}{4}$ in. deep + $1\frac{1}{2}$ in. control stick projection.

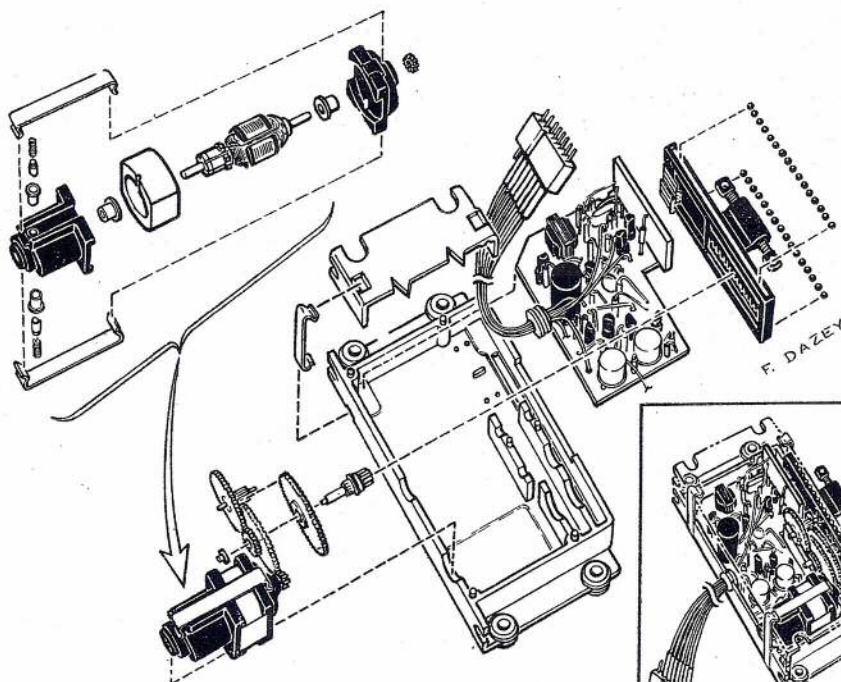
Aerial

Four sections telescopic. $12\frac{3}{4}$ in. retracted, $55\frac{1}{2}$ in. extended.

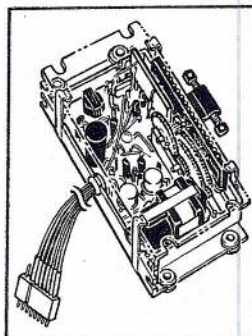
Case

16 s.w.g. grey anodised aluminium two piece folded construction. Two similar control stick assemblies comprising moulded nylon ball and socket unit through which control stick passes to engage in crossed yoke linkages also moulded in nylon and spring loaded nylon centring scissors units to centre the yoke. Nylon quadrant levers control the position of the centring devices so the complete control stick moves with the trim lever. This has the effect of reducing the throw on one side of neutral and extending it on the other. The overall effect remains the same so that the full throw position of the servos is unaffected. The centring springs are sufficiently strong to resist accidental movement say, of the elevator moving aileron or vice versa and the other control is neutral. The throttle control is fitted with a friction brake and the "trim" lever is not connected in this case.

The complete circuit is built on a $\frac{3}{16}$ in. glass epoxy p.c. board and occupies about half the case. A Gould national nickel cadmium power pack provides 12v. supply and the circuit board also carries a charger (for 110v. input). The mains lead plugs into a socket into the bottom of the case, a second socket takes the receiver battery plug, both Tx and Rx batteries have to be charged in series and in this country, a mains transformer is necessary to bring the voltage down to 110v. input. A safety catch fitted at the front of the case locks the switch on the "off"



Left: An exploded view of the Bonner proportional servo for use with the Digimite, it will be noted that the bearings are split and integral with nylon case, the output arm traveller, wipers and rack unit, run on ball bearings illustrated. The servo is shown approximately full size in the photo below. Note multiple lugs for attaching the servo either way round.



position thus transferring the battery connections to the charger circuit and switching the meter to indicate condition of charge.

Test Figures

Currents

12v.

Aerial retracted: 100 mA

Aerial extended: 80 mA

Output

As far as could be ascertained from field strength meter approximately $\frac{1}{2}$ watt.

Temperature Stability

Tx was cooled to approximately 32 deg. F. and heated to approximately 120 deg. F. with no measurable change in the performance of the system.

Voltage Stability

Tx was operated until the battery load voltage read 11v. resulting in a reduction in output but no apparent change in the performance of the complete system. Operating together the Rx with four servos tends to run its battery down first and a slow servo response gives a warning that charging is necessary.

The Tx balances well and the controls are comfortable to handle.

RECEIVER

The receiver comprises a four transistor superhet using three I.F. stages, the output is fed through a squaring amplifier to the ancillary circuits which comprise lockout, reset, fail-safe and four logic units which feed through a diode network giving eight outputs.

Physical Data

Size

$3\frac{1}{16}$ x $2\frac{1}{16}$ x $1\frac{1}{8}$ in. deep.

Weight

5 oz.

Harness

Nine cables 6 in. long terminating in miniature sockets. Additional power harness with plug and socket either end and 4-pole switch (harness length 18 in. long, weight $\frac{1}{2}$ oz.). Rx aerial 36 in. long. Externally accessible aerial tuning control.

Construction

16 s.w.g. aluminium chassis carries two $\frac{1}{16}$ in. glass epoxy p.c. boards with aluminium spacers. 20 s.w.g. aluminium cover, grey anodised finish.

Test Figures

The Rx draws 6v. 34 mA total current (manufacturer's figures Rx 3.8 mA logic section 8.4 mA,



regulator 21.8 mA). We also checked the current with four servos in the circuit (8.4v. total supply). Idle condition 150 mA one servo moving 200 mA, two servos: 250, three servos: 300, four servos: 350 mA, fail-safe condition 150 mA, one servo stalled 170 mA (an interesting condition, stall current being represented as 20 mA compared with a light operating point of 50 mA. We concluded that the particular switching circuit reviewed is dependent on the servo actually moving in order to switch in the next "step").

Sensitivity

Estimated between 2 and 4 mV., nature of the complete circuit made measurements a little difficult.

Temperature Stability

Performance of complete system unaffected between approximately 32 deg. F. and 120 deg. F.

Voltage Stability

Rx/servo supply was allowed to drop to 7v. Sensitivity was considerably reduced and the servos barely moved.

Interference

The example tested was sensitive to impulse interference to an extent which caused the servos to twitch, the receiver also responded by going fail-safe in the presence of a strong signal on an adjacent channel. This condition occurred when the Tx was operated with its aerial retracted to simulate extreme range.

SERVOS

All the servos are similar although available in centre or end fail-safe mode, the only difference would appear to be in the type of fail-safe switching plate used. The servos represent a completely new design as shown in the cut-away drawing, the two piece hard nylon case is divided lengthwise and a servo is completely symmetrical. Since it is impossible to reverse the action of the servo for different installation, the whole servo is simply turned round. There are mounting lugs on both sides of the case and on the bottom to take soft rubber grommets and Bonner servomounts. A new Bonner motor is used and the three stage nylon gear train terminates in a rack and pinion drive. The large moving plate which carries the output lever runs on 32 ball bearings and the output lever carries two adjustable eyelets for connecting pushrods to either end. This makes aileron linkage easy, similarly nosewheel/rudder linkages are neatly accomplished.

The servos contained far more components than is usual for a proportional servo but the servo is little larger than a standard Transmille, we understand that Transmilles are to be built from the same parts but with simpler circuitry.

No screws or bolts are used in the assembly, the two case halves form split bearings for the gear train and serve to hold all the components in their respective positions. Locating spigots ensure rigidity and the case halves are clamped together with four spring clips. Inquisitive types are warned not to disassemble the servos, this procedure invalidates the guarantee, releases all the ball bearings and other parts which could be tricky to re-assemble correctly. The circuit board alone has considerably more components than a single channel receiver. Each servo has its own sensing circuit in addition to a switching amplifier.

Physical Data

Size

3½ in. long x 1½ in. deep + ⅜ in. for output arm x 1⅛ in. width (all dimensions over the lugs).

Weight

3½ oz.

Harness

Seven wire cable 6 in. long with 8 pin plugs. Adjustable eyelets in output lever take 16 s.w.g. wire pushrod ends or Dubro clevises.

Case

Hard nylon, grey. Harness emerges from bottom of case but just clears surface to which the servo is fitted when carefully laid out.

Throw

.62 in. from end to end. Trim movement .1 in. each side of neutral (total throw with full trim is thus .52 in.). Motion is linear.

Float

Mechanical float is small; approximately 1 per cent.

Centring Accuracy

99 per cent.

Fail-Safe

The servo fail-safed to mechanical neutral not trim neutral.

Test Figures

Current

See Rx test.

Output

Maximum load for full speed operation 24 oz.

Maximum load for sure operation 41 oz. (servo very slow).

Stall load 52 oz. (servo just "ticks" as motor is switched on and off).

Manufacturers claim 3½ lb. stall, this should not be taken as a working figure. 24 oz. should be adequate for an aerobatic model.

Transit Time

0.45 neutral to limit, 0.9 sec. limit to limit (trim neutral).

Actual transit time including position error: position to neutral 0.6 sec.

This reading was obtained by timing the control stick in the Tx when released from limit to neutral and timing the servo response both traces being recorded on the analyser simultaneously, the lag being almost the same as the control stick return time representing the error of .045 sec. between servo position and control stick position when the stick was released. It should be pointed out that reed servos are sometimes faster.

Whilst the steps in which the servo operates were clearly recorded as increments of "control" surface movement from the analyser it seems unlikely that the difference between one step and the next (1 per cent increments of neutral to limit), would be wide enough to be noticeable in flight.

Positional Accuracy

Excellent. It was not possible to discern any discrepancy between the final position of the servo and

(Continued on page 422)

DIGIMITE TEST (Continued from page 417)

the control stick as recorded at loads up to the point when the servo is stalled. This is the best response in terms of positional accuracy.

Interaction

There is no interaction between any of the controls and all servos have a similar operating characteristic irrespective of which receiver outputs are connected to them.

Temperature

The servos underwent the same temperature tests and no change in the performance could be detected on the recording.

Vibration

The servos were subjected to standard vibration test; the rubber mounting grommets absorbed approx. 70 per cent of the vibration imposed. No G test could be conducted due to the bulk of the equipment (an alternative method of imposing G loads on more complex equipment will have to be devised sooner or later).

Complete System

Although each element in the system has been dealt with, the following points relating to the complete system should be noted. During the temperature test humidity was high, this apparently had no effect on the performance of the complete system. Endurance from full charge was 3½ hours continuous, the Tx battery having less work to do would probably have a longer duration.

Weight of a typical aircraft installation using four servos totals 29 oz. The servos are strongly constructed and should stand up to more than average mechanical abuse in the model.

Price

£289—provisional (prices vary).

Manufacturer

Bonner Specialties, 9522 Jefferson Boulevard, Culver City, California.

British Service

Southern Radio Control, 1121B London Road, Norbury, S.W.16.

CLASSIFIED ADVERTISEMENTS

REMCON 12 Tx and matching superhet Rx. Out of sight range and good tone stability £25; reply to R. Hawes, 4 Winston Crescent, High Barnes, Sunderland, Co. Durham.

WANTED: Six channel transmitter and/or receiver, ½ c.c. watercooled diesel, and cheap 2½ or 3½ c.c. aircooled diesel. Halliday, 97 Sweetloves Lane, Bolton.

PRINTED circuit boards supplied for any circuit. Simply send full size drawing of board. Prices include drilling. 6d. per sq. inch, plus 2/6d. processing. Post free. Temple, 12 Beech House Road, Croydon, Surrey.

FOR SALE: Radio control 8 channel Tx/Rx, 3.5 c.c. engine, 12v. boat motor £15, Heathkit 10-12-U 5 in. oscilloscope £30, Jason FMT3 Tuner £15. B. Station, 97 Edward Wilson House, Hesters Way, Cheltenham.

KEIL KRAFT FALCON, 8 footer, beautifully rebuilt, nylon covered. Taplin Twin Mk. II and R.E.P. Sextone. A delight to fly. Demonstrated, £35 o.n.o. DIBLE, ABBOTSBROOK, BOURNE END (608), BUCKS.

GOVERNMENT Surplus Electrical and Radio Equipment. Our new catalogue No. 16 ready now, 2/6d. Post Free, cost refunded on purchase of goods over £2. Arthur Sallis Radio Control Ltd., 93 North Road, Brighton.

BOAT KITS: Glass Fibre Hulls; Pre-cut parts; 'Sunga' 30 in., £4.19.11d. 'R.M.2' 42 in., £7.16.6d. and £8.14.0d. Bare Hull, £1.14.5d. S.A.E. for illustrated leaflets. RYGLASS MOULDED PRODUCTS, 2 GORDON STREET, WAVERTREE, LIVERPOOL 15.

HOLIDAY ANNOUNCEMENT: GONE FLYING—SEE YOU IN SWEDEN?—CLOSED AUGUST 7th UNTIL AUGUST 27th—ED. JOHNSON, RADIO CONTROL, LARKHILL, WILTS, ENGLAND.

£15 O.N.O. R.E.P. 8 Channel Xtal controlled Tx relay Rx. Good working order. J. Langridge, 49 West Valley Road, Hemel Hempstead, Herts.

GRUNDIG 8 Tx crystal DEACs £35. 2 filters, £7.15.0d. each. All brand new. Waylands Model Shop, 39 Derby Road, Heanor, Derbyshire.

WANTED: Discarded multi airframe for use as trainer, Week-days, 9 a.m. to 6 p.m. Radio Maintenance Services, Toothill Lane, Mansfield.

R.C.S. Superhet 10 channel receiver, matching bistimul valve transmitter. Ground range over ¼ mile. £40. Terry, 42 Trinity Street, London, S.E.1.

LATEST Orbit 12 channel Tx & Rx complete with 5 new Citizen-ship servos, owner gone proportional, £115, o.n.o., ring Watford 42859. M. J. Wiltshire, 97 Tudor Avenue, Watford, Herts.

THE MC/Q6 'MINI'

Ready-built, tested and guaranteed, only £5.5.0d., post free. A single-channel tuned filter receiver, with the exceptionally high sensitivity of 1µv.

FEATURES: 6 transistor circuit on gold-plated glass epoxy board. Size: 2" x 1½" x ½" high. Weight: 1 oz. Single battery 3 to 6v.; unaffected by electric motor brush noise. FLY THREE AT THE SAME TIME

DEREK A. OLLEY, 33 BROOKLY GARDENS, FLEET, HANTS

GALLATROL PROPORTIONAL RUDDER + ELEVATOR

A COMPLETE RELAYLESS GALLOPING GHOST SYSTEM
READY FOR INSTALLATION

| | |
|--|---------|
| 10 Transistor Proportional Output Tx less Aerial | £22 2 0 |
| 8 Transistor Rx + Servo Amplifier | £8 6 6 |
| Modified M.M. Motor Servo (one required) | £1 12 0 |

OR IN KIT FORM WITH SELECTED COMPONENTS

| | |
|--|----------|
| Tx, C/Finish Case, Drilled P.C., Components, etc. | £17 10 0 |
| Rx, Plastic Case, Drilled P.C., Components, Wire, etc. | £6 3 6 |
| Tunable Matched C/L Aerial (Socket 3/6d. extra) | £2 5 0 |

Plus full instructions.

● PROPORTIONAL RUDDER PLUS ELEVATOR

● IN FLIGHT TRIM ON EACH SURFACE

● AIRBORNE WEIGHT LESS THAN :

8 ozs. STANDARD ; 6 ozs. LIGHTWEIGHT

After Sale Service : C.W.O.
TIPPETT, 35 MAPLEBECK ROAD, SHEFFIELD 9

NEW OPPORTUNITIES FOR YOU IN BUSINESS MANAGEMENT

If you are over 30, have business ability, are capable of controlling a Sales Area, this could be your chance to get ahead rapidly. The manufacturers of a revolutionary new electrical product can offer rewarding opportunities to go-ahead people with the right qualifications. The enormous sales potential of the product has been proven and it has received very favourable and widespread publicity in the National and Trade Press, resulting in large home and export orders.

Write for full details now to :
GRENTOLL ADVERTISING LTD., 43 DOVER ST., LONDON, W.1

MODEL RADIO

(Jack Fisher & Co.) Phone : 63765

NEW ADDRESS :

"Modelradio", 1 George Street, Newcastle-under-Lyme, Staffs.

The BEST OF EQUIPMENT ON THE BEST OF TERMS.

Superb Kraft, Splendid Citizenship, Proven F & M, Mighty Modelectric, Magnificent Min-X, Opulent O.S., New R.E.P., Nimble Nucleonic, Remcon Service, Circuits, suggestions, books supplied. Stamped envelope please for Terms and Lists. American "RCM" 5/3; "Single R/C" 5/9; "R.C. Circuits" 8/3 (including post). Proportional £85-£300 (free aspirins with invoices). TINYTONE Rx 6/9.6d. (assembly service). Part-exchanges on Radios, TV's, Minivans, Cookers, Pets & Problems! Remcon Rx/Tx, £32; Amplified Duramites, £8.5.0d.

HAMMER FINISH PAINT

The modern finish for electronics. Can be BRUSHED or sprayed. Blue or Silver. 2½ oz. tins 3/6, post 8d., ½ pint 7/6, post 1/9, 1 pint 15/-. post 2/9. Orders over 30/- post free. Retailers supplied. S.A.E. for details. Amazing results! Return of post service.

FINNIGAN SPECIALITY PAINTS (RCM)

MICKLEY SQUARE : STOCKFIELD : NORTHUMBERLAND